

## STRATEGIES FOR PRESERVATION OF RARE PLANTS AND ANIMALS

G. Ledyard Stebbins<sup>1</sup>

**ABSTRACT.**— Human preservation of endangered species apparently commenced prior to recorded history with *Ginkgo biloba*, in China, a tree now known only under cultivation. A number of species have become extinct because man either failed to recognize their value or did not act quickly enough to preserve them even when their value was appreciated. A philosophy of conservation must be based upon cooperation with others looking to the future. Appropriate strategies that could be adapted from the military to achieve the objectives of species conservation include: (1) Know your enemy, his strengths and weaknesses, and the tactics he is likely to employ. (2) Inferior forces cannot hope to annihilate or completely neutralize an enemy, but can deflect him from his course. (3) If you have limited manpower, don't try to do too many things at once; concentrate on primary objectives. (4) Seek the most powerful allies you can find and learn to cooperate with them as nearly on their own terms as is compatible with your objectives. (5) Soften the enemy by harassment, when possible, before beginning the final attack. (6) Make use of all the time that is available; do not risk defeat by premature attack. (7) Never give in as long as there is hope. (8) The most important principle of all, never underestimate what you are doing.

The first rare species to have been preserved by humans was *Ginkgo biloba*, the Chinese Maiden Hair Tree. Nobody has ever seen it as a wild tree. The first Europeans to see and name it found it in the courtyards of the temples of China. Fossils indicate that during the Tertiary period, 30 or more million years ago, it was widespread through the Northern Hemisphere, but by the time humans had appeared on the scene it was already confined to China. Where did it grow as a native and why was it preserved in cultivation? A possible answer to these questions is provided by clues given me by a good scientific friend of mine, the late Edgar Anderson. He had one of the most remarkable perceptions for understanding cultivated plants and their relationships to their wild ancestors. He said, "Ledyard, have you ever thought about this fact—that the trees which are most successful along the streets of our cities are those which are native to the banks of great rivers or deltas? This is because a river tree is used to being flooded at one season and parched dry at another season, having heavy soil dumped on it, and big logs fall over it, receiving all the punishment that a tree gets under street conditions." *Ginkgo* is such a tree. I was impressed by this many years ago when I was working at Columbia

University in a laboratory suite on the eighth floor of the biology building there. I looked out every morning at the top of the *Ginkgo* tree eight stories above the courtyard where that tree had been planted. In the middle of New York City, it was certainly a very successful tree.

The Chinese plain is traversed by two huge rivers, the Yangtze and the Hoang Ho (the Yellow River). Although the climate of China is a forest climate, those plains are now completely denuded of native trees. Cultivation extends right to the edges of the rivers. Presumably those forests were cut down long before the Christian Era. My speculation is that *Ginkgo* was an element in ancient Chinese riparian forests. When the forests were being cut down, the priests of the temples thought it an unusual tree, and having medicinal properties. They brought in the seeds and saved trees in the temple courtyards. They were the first conservationists I can think of. We come from a long and honorable lineage.

Nevertheless, the concept of conservation became almost extinct during the earlier centuries of our own millennium. The past 500 years have witnessed the most extensive extinction of animal species due to a single cause to have happened during a 500-year period throughout the evolutionary history of

<sup>1</sup>Department of Genetics, University of California, Davis, California 95616.

animals. That cause is human interference with nature. Among the well-known victims of human destruction are the dodo, the great auk, the passenger pigeon, the plains bison, the moas of New Zealand, the Asiatic lion, the European forest horse, and the native wild horses that formerly roamed the American plains. Many others could be mentioned. Must this destruction continue or can we stop it? Before considering means of reversing this trend, we must be fully aware of the problem we face. Our opponents are not merely a few greedy men who are out to make a fast buck in total disregard of other human values. We certainly must face and neutralize such enemies by any means available to us. In addition, we must realize that our efforts are running counter to a life-style that was adopted by prehumans long before our own species, *Homo sapiens*, came into existence. Recently acquired knowledge about human evolution suggests strongly the belief that when human ancestors left the shelter of the tropical forests that were their original homes and began to live by hunting game in savanna areas, they adopted, partly in a subconscious way, a life-style that was based upon two objectives: destroy or annihilate the enemy and exploit the resource. The first enemies of humanity were predators. Hence the extinction of the Asiatic lion a short time after the Christian Era and in very recent times, the destruction of the California grizzly bear, the symbol of our state, during the 19th century.

Many more species have become extinct as a result, either directly or indirectly, of the philosophy: exploit the resource. Before humans started to cultivate fields or domesticate animals, the resources were wild game animals as well as wild plants that provided edible seeds, fruits, and roots—consequently early exploitation of wild horses took place in most of their range. Anthropologists have uncovered, particularly in the new world, many sites suggesting that primitive humans drove horses over cliffs, slaughtering them wholesale, picking up the bodies of those they could carry and using them for food, hides, and other purposes. This to them was a normal way of life. The destruction of flightless, slow-moving island birds such as the dodo and the great auk by European sailors and

the moas in New Zealand by colonizing Maori people came about as a natural result of a desire for fresh meat on the part of men who had been deprived of it for a very long time. Other species have become totally extinct or preserved only in cultivation or domestication because their existence involved competition with resources of agriculture or domestication. Ginkgo has already been mentioned. Another is probably the ancestor of domestic cattle. As is shown so beautifully in paintings made by men who lived in Europe from 15,000 to 20,000 years ago, wild bulls were hunted as game. Archaeological records suggest that the first domestication of cattle was connected with religious rites. Bearing curved horns that resembled a crescent moon, cattle were regarded by some ancient tribes as sacred to the moon goddess. Sacred bulls of ancient Crete are well known to history, and, in India, sacred cows that cannot be killed still cause trouble. The expression "holy cow" is more than a casual bit of modern slang. It follows a long and venerable history. Domestication of cattle was one cause for the near extinction of wild animals. A beast as strong as a bull could be handled only if reasonably tame, yet whenever cows belonging to herds of domestic cattle were covered by wild bulls and produced calves from those bulls, genes for wildness introduced in this fashion must have counteracted the effects of primitive husbandmen to breed tractable herds. Wild cattle became not only a resource to be exploited, but also enemies to domestication. Modern history gives us similar examples of species that have become extinct or nearly so because of competition with various kinds of human efforts. The senseless slaughter of plains bison and passenger pigeons during the last century were not the only cause for the extinction of these species. Nesting grounds for the passenger pigeon were in rich bottom lands highly suitable for agriculture. Farm produce was regarded not only by the farmers themselves, but by everybody as more important than nests of pigeons. The buffalo competed with both cattle and dry farmers. Once the prairies were fenced in, the wanderers could no longer survive because their basic way of life had become impossible. More recently, plant species have become extinct because

growing cities have destroyed their habitat. Of two species that once grew only within the crowded city limits of San Francisco, one of them, *Sanicula maritima*, is completely extinct and another, *Arctostaphylos franciscana*, the San Francisco Manzanita, is represented by a single wild shrub plus many in gardens.

These examples should teach us the following lesson: the main barrier to preserving our priceless heritage of rare animals and plants is not human greed. It is, rather, the natural tendency for people of all kinds to be shortsighted and to prefer to satisfy immediate needs rather than long-term benefits, particularly those which will be enjoyed only by their progeny of successors.

Moreover, conservationists are allied with a whole series of people who realize the need for reversing a life-style that has dominated humanity for over a million years. Annihilation and liquidation must be replaced by collaboration, or at least tolerance on all fronts. Exploitation must be replaced by conservation. The future existence of humanity depends on the success of efforts toward this reversal. Saving rare plants and animals is a small but highly significant part of mankind's vital efforts to survive during the coming centuries.

From the above considerations, a philosophy of conservation must be based more upon cooperation with others and looking toward the future. Education that might convert apathy into a true realization of the problem is preferable to a direct attack on an enemy, who is painted in black colors of uncompromising greed. Conservation is a form of politics, whether we like it or not. In a democracy or in a community of free nations, political action, especially when it is practiced of necessity by a small minority, depends for its success on adopting and exploiting to the limit strategies that are appropriate for each particular goal. The following well-known military strategies are particularly appropriate for conservationists who are seeking to preserve rare animals and plants. First, know your enemy, his strengths and weaknesses, and the tactics he is likely to employ. Potential enemies are any group of people who for reasons that may seem to be completely valid and justifiable are likely to

destroy rare plants and animals and their natural habitat. Among them are people engaged in agriculture, livestock raising, operators of mines or quarries, prospectors, urban and suburban developers, developers of mass recreational facilities such as golf courses and ski slopes, and conservationists who believe the greatest need for future civilizations is water backed up in giant dams and water power projects. Each of these groups is armed with verbal weapons that may appear, on the surface, to be equally or more powerful than any of those in our arsenal.

The growing population needs more food. New resources of minerals and energy provided by coal, oil, and gas are vital to the nation's growing economy. The greatest need of the United States is more and better housing. Recreational development such as golf courses and ski slopes make life more enjoyable for millions. The rare plants and rare animals of the wilderness can be appreciated and enjoyed only by a small cult of nature lovers. The realistic way to provide for future generations is to build dams that will make more water and power available to people. All of these arguments sound logical, realistic, and incontrovertible. In a way they are. Attempts to refute them directly will certainly end in failure. Our strategy must be to recognize the partial validity of these and similar arguments. We must work around them, not try to overthrow them.

The second principle is: inferior forces cannot hope to annihilate or completely neutralize an enemy, but they can deflect the enemy from its course. On this basis, reasonable answers to the arguments mentioned above could be found. Surely more food, minerals, energy resources, and housing are needed, but with few exceptions these can be had by developments that do not destroy precious and irreplaceable habitats and the native species they contain. The same can be said even more justifiably about the development of golf courses and ski slopes. As a matter of fact, I have taken part in opposition to development projects that are ill advised and ill conceived from a strictly economical point of view, regardless of conservation. Opposition from conservationists in those cases called attention to the unsound nature of these projects and, by causing them to be abandoned,

saved the developers or their innocent clients from economic embarrassment or possible disaster.

One of these is located in the north coast ranges of California. It was a proposed resort development on the shore of Boggs Lake, a large, vernal pool. In April or May, during the wet season, Boggs Lake is a sheet of blue, limpid water almost a mile in diameter surrounded by gently sloping gravelly beaches, behind which is a cool pine forest. Situated in the mountains almost 3000 feet above level, far from the nearest city or freeway, it would seem to be an ideal place for a hideaway where a cool forest glade and pure mountain water could be enjoyed. That description, and accompanying photos used by developers were based only on its spring condition. Its appearance, however, is highly deceptive. Boggs has no spring-fed inlet and is exposed continuously for five months throughout the California summer to a hot, dry sun. If one, therefore, visits this "lake" in August or September, the former lake has become a dry and dusty flat with a few soggy places in its center. Pine forests are still there, but they too have become hot and dry and present a continuous fire hazard.

Pools of this kind usually harbor several rare and endemic species. Boggs Lake is one of the best of this kind for botanical research. When members of the California Native Plant Society heard about a proposed resort planned along its shores, we went in great number to a hearing in the Lake County Courthouse to present our views. Before doing so, we took the trouble to walk around the area carefully and acquired a greater familiarity with the terrain than had the developers. Their publicity was based chiefly upon an airplane survey. Our view of the situation was strong enough to dissuade both the county supervisors and the developers from continuing the project. Boggs Lake was then acquired by the Nature Conservancy and its unique habitat is permanently preserved.

The third principle is, if you have limited manpower, don't try to do too many things at once. Concentrate on primary objectives. In terms of conservation strategy, do not spend valuable time on every species that is rare and local. Most of the rare species that live in national parks, state parks, wilderness areas,

that have been set aside by the national park and similar privately controlled areas, need only occasional monitoring to see that provisions and rules for preservation are being carried out. Sometimes the officials need to be informed. I remember an example of a grass in the Sierra Nevada, a rare species, *Stipa latigumis*, known from only about three localities. I had a suspicion about its origin. I suspected that it evolved in what now is a genetically familiar fashion: crossing between two other species of *Stipa* and doubling the chromosome number: an allopolyploid. The most accessible place for this species, according to herbarium labels, was Lost Arrow Camp in Yosemite Valley. In Yosemite National Park, as in other parks, a collecting permit is required. Collecting permits always say in very large capitals, NO COLLECTING OF ANY KIND IS PERMITTED ON THE FLOOR OF THE VALLEY. Nevertheless, I went to the park naturalist's office to ask for a permit. When I explained what I wanted, the park naturalist himself received me. He said, "Where does it grow in the valley?"

"The labels say Lost Arrow Campground."

"This is where the government center is built."

"Do you think there are any native areas here?"

"I think I know them pretty well, but I don't think you'll find anything unusual here at all."

"May I look? And if I find it here, may I collect it?"

"Well, I guess you can."

We started looking. We found it in the front yard of the private residence of the park naturalist himself. Its allopolyploid nature was demonstrated by Dr. Richard Pohl.

Other rare species, not in the national parks or preserved areas, nevertheless grow in such inaccessible spots that they are very unlikely to be destroyed. An example is a species of the genus *Eupatorium* that many years ago I discovered on a north-facing limestone cliff near Lake Shasta. *Eupatorium shastensis* is always perched on cliffs, and 80 percent of the plants of it are so high up on the cliffs that no one can reach them except by specialized rock climbing techniques. There is danger, possibly, from prospecting

or blasting of these limestone cliffs, except for the fact that they are in very rugged terrain, one of them isolated from any highway by the waters of Lake Shasta and the other on the summit of a very rugged mountain. Bringing in equipment to mine these areas would be extremely expensive. Because it is on their land, the Forest Service knows about it and I believe will not issue permits for prospectors or mining on these rather unusual limestone cliffs. This case requires monitoring, even if there is no formal preservation.

General applications of this strategy, I believe, is to keep lists of rare and endangered species as short as practicable, to pay as much attention as possible to the amount of danger and the nature of the danger to which a species might be exposed and to determine actual rarity in terms of space occupied and actual numbers of individuals in each population. Government officials and leaders of general conservationist organizations, such as the Sierra Club, should not be presented with lists of two or three hundred species with unfamiliar names. I suspect that in many instances these are filed in some cabinet, which a secretary might open every six months or so. Here is a situation where the more we know about potential and imminent danger, the better off we are.

The fourth principle is to seek the most powerful allies you can find and learn to cooperate with them on as nearly their own terms as is compatible with your objectives. My happiest experience with powerful allies resulted in partial preservation in an area that for 25 years previously had been very dear to my heart. This is a little-known portion of the fabulously scenic Monterey Peninsula on the coast of central California. That area, a small, ancient "raised beach" millions of years old (Pliocene), is underlaid by a sterile, hard, and impervious "hard pan" soil. Its plant communities contain so many problems in evolution and plant geography that I have nicknamed it "Evolution Hill." Its most distinctive tree species are the Bishop pine and the narrowly endemic, rare dwarf, Gowen cypress. Each time I have taken students to this area it has given me cause for apprehension. We could traverse by foot a network of trails and rough roads. The owners had the

trees and brush cut so that they could very easily be converted into paved streets and the whole place put into a resort development. Ownership is in the hands of an exclusive multimillion dollar organization, Del Monte Properties, which was then the fiefdom of one of the most prominent citizens of northern California, Samuel F. B. Morse. One day during the 1950s I obtained an appointment with Mr. Morse to discuss the future of Evolution Hill. The great man was polite and cordial. He said that he too was much interested in saving the area and to see that it remained preserved as long as he remained in control. He could not, however, make commitments that would tie the hands of his successors. Mr. Morse at that time was in his late seventies and he had clearly given me only a temporary stay of execution. Several years later, after Mr. Morse's death, the blow fell. I received a telephone call from a prominent resident of the peninsula, the director of a nearby laboratory. He said, "I want you to come down to Salinas to attend a meeting of the County Planning Commission. The new director of Del Monte, who used to be vice-president of the Corning Glass Works, wants to start a sand quarry for glass in the forest right behind our house." I realized at once that Evolution Hill was in danger, but also that we members of the California Native Plant Society had powerful allies. Several of the most wealthy and prominent homeowners who had bought and built in the forest in order to have quiet solitude with undisturbed woodlands for hiking and horseback riding felt that their life-style was severely threatened and that the hundreds of thousands of dollars they had invested in their homes might go down the drain. The result of the first hearing was noncommittal, but the stay of execution was maintained. No permit to quarry was issued. We then organized a joint fact-finding site visit attended by more than 100 members of the Native Plant Society plus several homeowners. Such an event deserved and received good newspaper publicity in the area. Hearings and litigation continued for about two years. Finally the quarry-minded individuals from the Del Monte Company gave up the sponge. They donated a portion of the hill to the county to be set aside as the S.F.B. Morse Preserve and

agreed not to quarry for sand in an area near the established homes. We would have preferred to see the preservation of all of Evolution Hill, and this may still be possible. Ten years after this partial victory, it is still as I first saw it; no homes have been built in the area.

The fifth principle of strategy: if possible, soften the enemy by harassment before beginning the final attack. This principle is well illustrated by an experience we had a few years ago in an endemic area in the Sierra Foothills, known as Pine Hill. This hill, 25 miles east of the state capitol of Sacramento, about 2000 feet high, has a number of endemic species. The most spectacular of these is a flannel bush, *Fremontodendron decumbens*, described by Dr. Robert Lloyd. It is noted for its prostrate habit and its copper-colored flowers, where most flannel bushes have bright yellow flowers. It is a very distinctive species, not known anywhere except on Pine Hill. I say with some confidence that my friends and I have combed over every hill in the neighborhood that could possibly hold it and we have never found it, so I'm certain the central ridge of Pine Hill is the only place where this shrub grows.

One day a member of the Native Plant Society visited Pine Hill only to find that the Forest Service, in order to construct a fire break, had cut down almost all of the shrub of *Fremontodendron*, and it looked as if it was gone. His reaction was immediate and positive. He wrote a strongly worded article that was soon published in our society's journal. The article brought a flood of letters from outraged members of the Native Plant Society to the office desk of the district manager. That was in May. In October I got a letter from a friend in the nearest town, Placerville: "Ledyard, I want you to come. I've got to go out with the ranger to Pine Hill." Why? "Because they want to put in a little powerplant, about 10 × 20 feet and they want to do it without having all the flack that we gave them on the fire break." So we went up there and we told them where to put it, a place where there were almost no plants. Soon after, we were able to enlist the powerful ally. The husband of the secretary of our Sacramento chapter of the Native Plant Society, Warner Marsh, had been in

the Sacramento office of the State Forest Service for many years and was highly respected by all personnel in that service. So, Warner went out with one or two other people and the ranger and put a little pink ribbon on every shrub of the *Fremontodendron*. Fortunately, it is quite a resilient shrub. Cutting down the branches didn't destroy the roots, and so new branches came up. They're back again and now the California State Forest Service isn't going to disturb them. We are having other problems with Pine Hill because of changes in the state government organization, but we're still very optimistic that the whole area will be preserved.

The sixth principle of strategy is to make use of all the time that is available. Do not risk defeat by premature attack. Many conservationists who are aware that an unusual habitat is threatened by mining, quarrying, development, or some other way, tend to magnify the threat and particularly its immediacy. Sometimes this attitude is justified and necessary; other times it is not. Surely, if the developer is known to have his eyes on one of our favorite spots, we must act quickly with all resources at our command. Nevertheless, we cannot be stampeded by a potential danger which may not be realized for some time. Here again precise knowledge of the danger that threatens a rare species or community is of the utmost importance.

The seventh principle is never give in as long as there is hope. One can lose several battles but still win the campaign. The last two principles are well illustrated by the campaign to save the Ione Manzanita area on the eastern margin of California's central valley, one of the most dramatic of California's ecological islands. I call it an ecological island because the soil is so different from the surrounding soils that the species living there are isolated as if they were on an oceanic island surrounded by a sea of grass and oaks. Another inhabitant of the barrens is a species of buckwheat, *Eriogonum opricum*, described about 25 years ago by J. T. Howell.

When the California Native Plant Society was formed, one of our objectives I thought of almost immediately was saving Ione Manzanita, so a group of us went to the Amador County Courthouse first to find out who owned it. The results were not encouraging.

The whole area belongs to a syndicate controlled by a large San Francisco bank, which leases land to miners and quarriers because there is a clay of extremely high value. When we approached one of the officials of this company, we got a very emphatic reply, "We'll mine every blank blank cubic foot of that sand and clay and we dare you blank blank s. o. b.'s to stop us."

Somewhat later, we were still trying to find a way around them and went on a Sunday when we thought nobody would be there to look for another spot for the *Eriogonum epricum*. We ran into some people who turned out to be miners who were not mining on Sunday, but were hunting quail or something like that. They said, "What are you doing in our place?" We explained what we were doing. "You better get off. We're honest miners and we've been working this for 20 years. This place is full of rattlesnakes and I wish there were twice as many of them to keep you blank blank blanks from going on to it." Well we haven't given up. We've had articles in our journals. We've had publicity wherever we could find it. We've discussed it with the California Department of Parks and Recreation and other groups, and we have gained some allies. Meanwhile the quarries that existed for some time are still there and still working, but they haven't invaded any more territory than they had when we first started in 1966. So while there's life there is hope.

(NOTE: As this article was going to press, I received a welcome announcement: The central heart of the Ione Manzanita area has been purchased by the Nature Conservancy.)

The eighth and last principle—the most important principle of all—never underrate the importance of what you are doing. Human civilization is built on two great pillars. A pillar of knowledge and a pillar of beauty and its aesthetic appreciation, whether it be the beauty of nature, artistic creation, or the beauty of the spirit. Drs. Lovejoy and Clement this morning showed us part of a worldwide effort to save humanity from its own destruction. Fountains of knowledge can be

bound up in the most ugly and unattractive weeds we are trying to save.

A plant known only in a few suburban areas, which is now severely threatened, is a tar weed known as *Holocarpha macradenia*. Now tar weeds are among the nastiest weeds in California pastures. To try and tell a rancher that you want to save a tar weed is just like telling him to stop drinking beer. Well, it so happens that this species was part of a large-scale research project carried on by I. Clausen and D. D. Keck 25 or 30 years ago. They discovered that what the taxonomists had called two species are actually four morphologically recognizable ones. Among those four species, hybrids between almost any collections from two different localities were sterile or couldn't be made. In other words, hiding under first two and then four species is a whole series of little narrow endemic species, the nature of which is associated with chromosomal difference. In our quest for understanding the mechanisms of the origin of species, the tarweeds, including *Holocarpha macradenia*, could be a key group. Now we will have to resist the desire to succumb to the developers and keep the species alive, at least under cultivation. After all, the habitat will be gone anyway. The place where it has been known for the last 50 years is in association with wild oats and other introduced species. Its prehuman habitat was gone long ago. This is an example of a humble sticky, smelly, nasty weed which could be a gold mine of scientific information.

Now we should then come to the aesthetic value. My illustrations cannot equal the beauty you saw in the booklet of the National Wildlife Federation we all received this morning. I'll show finally just two slides which give a modest impression of the beauty of plant species. One is a Monterey cypress, growing on the granite cliffs facing the blue Pacific Ocean, with its picturesque branches and trunk growing out of solid granite. The other is a pure white flower of the California rose mallow centered with the deep maroon spot in the middle of the flower, growing in the hot valley in the middle of the summer.